US009098312B2

(12) **United States Patent**
Bullotta et al.

(10) **Patent No.: US 9,098,312 B2**
(45) **Date of Patent: Aug. 4, 2015**

(54) **METHODS FOR DYNAMICALLY GENERATING AN APPLICATION INTERFACE FOR A MODELED ENTITY AND DEVICES THEREOF**

(71) Applicant: **PTC Inc.**, Needham, MA (US)

(72) Inventors: **Rick Bullotta**, Phoenixville, PA (US); **John Schaefer**, Ambler, PA (US)

(73) Assignee: **PTC Inc.**, Needham, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 315 days.

(21) Appl. No.: **13/678,885**

(22) Filed: **Nov. 16, 2012**

(65) **Prior Publication Data**

US 2013/0124616 A1 May 16, 2013

Related U.S. Application Data

(60) Provisional application No. 61/560,371, filed on Nov. 16, 2011.

(51) **Int. Cl.**

G06F 15/16	(2006.01)
G06F 9/44	(2006.01)
H04L 29/08	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 9/4443*** (2013.01); ***H04L 67/28*** (2013.01); *G06F 8/30* (2013.01)

(58) **Field of Classification Search**

CPC H04L 67/32; H04L 67/28
USPC 709/203, 204, 223
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,656,112	A	4/1972	Paull
3,916,412	A	10/1975	Amoroso, Jr.
3,983,484	A	9/1976	Hodama
4,063,173	A	12/1977	Nelson et al.
4,103,250	A	7/1978	Jackson

(Continued)

FOREIGN PATENT DOCUMENTS

WO	WO-2008/115995	A1	9/2008
WO	WO-2014/145084	A1	9/2014

OTHER PUBLICATIONS

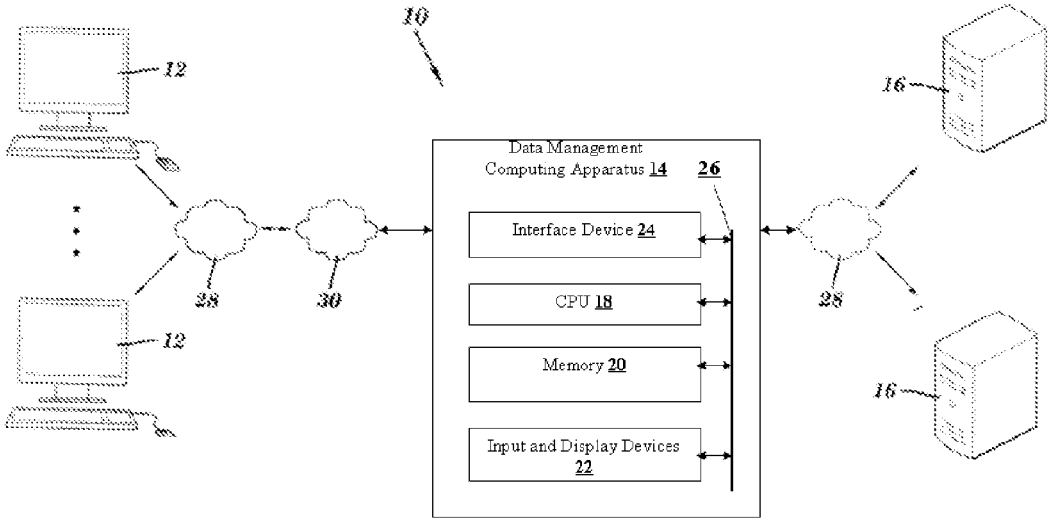
Shi, L. et al., Understanding Text Corpora with Multiple Facets, IEEE Symposium on Visual Analytics Science and Technology (VAST), 99-106 (2010).

Primary Examiner — Adnan Mirza
(74) *Attorney, Agent, or Firm* — Choate, Hall & Stewart LLP; William R. Haulbrook; Santiago Velez

(57) **ABSTRACT**

This technology generates a plurality of instances of things each including a dynamically generated interface structure and services associated with and properties of the corresponding one of the things. The services associated with and the properties of one of the plurality of instances of things for a selected one of the plurality of instances of things are retrieved and provided. A service definition for a selected one of the services is retrieved and provided based on the retrieved and provided services associated with and properties for the selected one of the plurality of instances of things. A requested consumption call for the selected one of the services is executed based on the retrieved service definition. A defined result set for the executed consumption call is provided in the dynamically generated interface structure associated with the requested one of the plurality of instances of things.

6 Claims, 3 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

4,134,068 A 1/1979 Richardson
4,216,546 A 8/1980 Litt
4,554,668 A 11/1985 Deman et al.
4,601,059 A 7/1986 Gammenthaler
4,680,582 A 7/1987 Mejia
4,704,585 A 11/1987 Lind
4,979,170 A 12/1990 Gilhousen et al.
5,113,416 A 5/1992 Lindell
5,134,615 A 7/1992 Freeburg et al.
5,159,704 A 10/1992 Pirolli et al.
5,276,703 A 1/1994 Budin et al.
5,361,401 A 11/1994 Pirillo
5,422,889 A 6/1995 Sevenhans et al.
5,454,010 A 9/1995 Leveque
5,479,441 A 12/1995 Tymes et al.
5,493,671 A 2/1996 Pitt et al.
5,515,365 A 5/1996 Sumner et al.
5,734,966 A 3/1998 Farrer et al.
5,737,609 A 4/1998 Reed et al.
5,805,442 A 9/1998 Crater et al.
5,909,640 A 6/1999 Farrer et al.
5,925,100 A 7/1999 Drewry et al.
6,169,992 B1 1/2001 Beall et al.
6,182,252 B1 1/2001 Wong et al.
6,198,480 B1 3/2001 Cotugno et al.
6,377,162 B1 4/2002 Delestienne et al.
6,430,602 B1 8/2002 Kay et al.
6,553,405 B1 4/2003 Desrochers
6,618,709 B1 9/2003 Sneeringer
6,675,193 B1 1/2004 Slavin et al.
6,757,714 B1 6/2004 Hansen
6,766,361 B1 7/2004 Venigalla
6,797,921 B1 9/2004 Niedereder et al.
6,810,522 B2 10/2004 Cook et al.
6,813,587 B2 11/2004 McIntyre et al.
6,850,255 B2 2/2005 Muschetto
6,859,757 B2 2/2005 Muehl et al.
6,915,330 B2 7/2005 Hardy et al.
6,993,555 B2 1/2006 Kay et al.
7,031,520 B2 4/2006 Tunney
7,046,134 B2 5/2006 Hansen
7,047,159 B2 5/2006 Muehl et al.
7,054,922 B2 5/2006 Kinney et al.
7,082,383 B2 7/2006 Baust et al.
7,082,460 B2 7/2006 Hansen et al.
7,117,239 B1 10/2006 Hansen
7,149,792 B1 12/2006 Hansen et al.
7,178,149 B2 2/2007 Hansen
7,185,014 B1 2/2007 Hansen
7,250,862 B2 7/2007 Bornhoevd et al.
7,254,601 B2 8/2007 Baller et al.
7,269,732 B2 9/2007 Kilian-Kehr
7,341,197 B2 3/2008 Muehl et al.
7,380,236 B2 5/2008 Hawley
7,496,911 B2 2/2009 Rowley et al.
7,529,750 B2 5/2009 Bair
7,536,673 B2 5/2009 Brendle et al.
7,555,355 B2 6/2009 Meyer
7,566,005 B2 7/2009 Heusermann et al.
7,570,755 B2 8/2009 Williams et al.
7,587,251 B2 9/2009 Hopsecger
7,591,006 B2 9/2009 Werner
7,593,917 B2 9/2009 Werner
7,613,290 B2 11/2009 Williams et al.
7,616,642 B2 11/2009 Anke et al.
7,617,198 B2 11/2009 Durvasula
7,624,092 B2 11/2009 Lieske et al.
7,624,371 B2 11/2009 Kulkarni et al.
7,644,120 B2 1/2010 Todorov et al.
7,644,129 B2 1/2010 Videlov
7,647,407 B2 1/2010 Omshehe et al.
7,650,607 B2 1/2010 Resnick et al.
7,653,902 B2 1/2010 Bozak et al.
7,673,141 B2 3/2010 Kilian-Kehr et al.
7,684,621 B2 3/2010 Tunney
7,703,024 B2 4/2010 Kautzleben et al.
7,707,550 B2 4/2010 Resnick et al.
7,725,815 B2 5/2010 Peters
7,728,838 B2 6/2010 Forney et al.
7,730,498 B2 6/2010 Resnick et al.
7,743,015 B2 6/2010 Schmitt
7,743,155 B2 6/2010 Pisharody et al.
7,752,335 B2 7/2010 Boxenhorn
7,757,234 B2 7/2010 Krebs
7,761,354 B2 7/2010 Kling et al.
7,774,369 B2 8/2010 Herzog et al.
7,779,089 B2 8/2010 Hessmer et al.
7,779,383 B2 8/2010 Bornhoevd et al.
7,783,984 B2 8/2010 Roediger et al.
7,802,238 B2 9/2010 Clinton
7,814,044 B2 10/2010 Schwerk
7,814,208 B2 10/2010 Stephenson et al.
7,817,039 B2 10/2010 Bornhoevd et al.
7,827,169 B2 11/2010 Enenkiel
7,831,600 B2 11/2010 Kilian
7,840,701 B2 11/2010 Hsu et al.
7,852,861 B2 12/2010 Wu et al.
7,853,241 B1 12/2010 Harrison
7,853,924 B2 12/2010 Curran
7,860,968 B2 12/2010 Bornhoevd et al.
7,865,442 B1 1/2011 Sowell
7,865,731 B2 1/2011 Kilian-Kehr
7,865,939 B2 1/2011 Schuster
7,873,666 B2 1/2011 Sauermann
7,882,148 B2 2/2011 Werner et al.
7,886,278 B2 2/2011 Stulski
7,890,388 B2 2/2011 Mariotti
7,890,568 B2 2/2011 Belenki
7,895,115 B2 2/2011 Bayyapu et al.
7,899,777 B2 3/2011 Baier et al.
7,899,803 B2 3/2011 Cotter et al.
7,908,278 B2 3/2011 Akkiraju et al.
7,917,629 B2 3/2011 Werner
7,921,137 B2 4/2011 Lieske et al.
7,921,686 B2 4/2011 Bagepalli et al.
7,925,979 B2 4/2011 Forney et al.
7,937,370 B2 5/2011 Hansen
7,937,408 B2 5/2011 Stuhec
7,945,691 B2 5/2011 Dharamshi
7,953,219 B2 5/2011 Freedman et al.
7,954,107 B2 5/2011 Mao et al.
7,954,115 B2 5/2011 Gisolfi
7,966,418 B2 6/2011 Shedrinsky
7,975,024 B2 7/2011 Nudler
7,987,176 B2 7/2011 Latzina et al.
7,987,193 B2 7/2011 Ganapam et al.
7,992,200 B2 8/2011 Kuehr-McLaren et al.
8,000,991 B2 8/2011 Montagut
8,005,879 B2 8/2011 Bornhoevd et al.
8,024,218 B2 9/2011 Kumar et al.
8,024,743 B2 9/2011 Werner
8,051,045 B2 11/2011 Vogler
8,055,758 B2 11/2011 Hansen
8,055,787 B2 11/2011 Victor et al.
8,060,886 B2 11/2011 Hansen
8,065,397 B2 11/2011 Taylor et al.
8,069,362 B2 11/2011 Gebhart et al.
8,073,331 B1 12/2011 Mazed
8,074,215 B2 12/2011 Cohen et al.
8,081,584 B2 12/2011 Thibault et al.
8,082,322 B1 12/2011 Pascarella et al.
8,090,452 B2 1/2012 Johnson et al.
8,090,552 B2 1/2012 Henry et al.
8,095,632 B2 1/2012 Hessmer et al.
8,108,543 B2 1/2012 Hansen
8,126,903 B2 2/2012 Lehmann et al.
8,127,237 B2 2/2012 Beringer
8,131,694 B2 3/2012 Bender et al.
8,131,838 B2 3/2012 Bornhoevd et al.
8,136,034 B2 3/2012 Stanton et al.
8,145,468 B2 3/2012 Fritzsche et al.
8,145,681 B2 3/2012 Macaleer et al.
8,151,257 B2 4/2012 Zachmann
8,156,117 B2 4/2012 Krylov et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,156,208 B2 4/2012 Bornhoevd et al.
8,156,473 B2 4/2012 Heidasch
8,183,995 B2 5/2012 Wang et al.
8,229,944 B2 7/2012 Latzina et al.
8,230,333 B2 7/2012 Decherd et al.
8,249,906 B2 8/2012 Ponce de Leon
8,250,169 B2 8/2012 Beringer et al.
8,254,249 B2 8/2012 Wen et al.
8,261,193 B1 9/2012 Alur et al.
8,271,935 B2 9/2012 Lewis
8,280,009 B2 10/2012 Stepanian
8,284,033 B2 10/2012 Moran
8,285,807 B2 10/2012 Slavin et al.
8,291,039 B2 10/2012 Shedrinsky
8,291,475 B2 10/2012 Jackson et al.
8,296,198 B2 10/2012 Bhatt et al.
8,296,266 B2 10/2012 Lehmann et al.
8,296,413 B2 10/2012 Bornhoevd et al.
8,301,770 B2 10/2012 van Coppenolle et al.
8,306,635 B2 11/2012 Pryor
8,312,383 B2 11/2012 Gilfix
8,321,790 B2 11/2012 Sherrill et al.
8,321,792 B1 11/2012 Alur et al.
8,331,855 B2 12/2012 Williams et al.
8,346,520 B2 1/2013 Lu et al.
8,359,116 B2 1/2013 Manthey
8,364,300 B2 1/2013 Pouyez et al.
8,370,479 B2 2/2013 Hart et al.
8,370,826 B2 2/2013 Johnson et al.
8,375,292 B2 2/2013 Coffman et al.
8,375,362 B1 2/2013 Brette et al.
RE44,110 E 3/2013 Venigalla
8,392,116 B2 3/2013 Lehmann et al.
8,392,561 B1 3/2013 Dyer et al.
8,396,929 B2 3/2013 Helfman et al.
8,397,056 B1 3/2013 Malks et al.
8,406,119 B2 3/2013 Taylor et al.
8,412,579 B2 4/2013 Gonzalez
8,417,764 B2 4/2013 Fletcher et al.
8,417,854 B2 4/2013 Weng et al.
8,423,418 B2 4/2013 Hald et al.
8,424,058 B2 4/2013 Vinogradov et al.
8,433,664 B2 4/2013 Ziegler et al.
8,433,815 B2 4/2013 van Coppenolle et al.
8,438,132 B1 5/2013 Dziuk et al.
8,442,933 B2 5/2013 Baier et al.
8,442,999 B2 5/2013 Gorelik et al.
8,443,069 B2 5/2013 Bagepalli et al.
8,443,071 B2 5/2013 Lu et al.
8,457,996 B2 6/2013 Winkler et al.
8,458,189 B1 6/2013 Ludwig et al.
8,458,315 B2 6/2013 Miche et al.
8,458,596 B1 6/2013 Malks et al.
8,458,600 B2 6/2013 Dheap et al.
8,473,317 B2 6/2013 Santoso et al.
8,478,861 B2 7/2013 Taylor et al.
8,484,156 B2 7/2013 Hancsarik et al.
8,489,527 B2 7/2013 van Coppenolle et al.
8,490,047 B2 7/2013 Petschnigg et al.
8,490,876 B2 7/2013 Tan et al.
8,495,072 B1 7/2013 Kapoor et al.
8,495,511 B2 7/2013 Redpath
8,495,683 B2 7/2013 van Coppenolle et al.
8,516,296 B2 8/2013 Mendu
8,516,383 B2 8/2013 Bryant et al.
8,521,621 B1 8/2013 Hetzer et al.
8,522,217 B2 8/2013 Dutta et al.
8,522,341 B2 8/2013 Nochta et al.
8,532,008 B2 9/2013 Das et al.
8,533,660 B2 9/2013 Mehr et al.
8,538,799 B2 9/2013 Haller et al.
8,543,568 B2 9/2013 Wagenblatt
8,547,838 B2 10/2013 Lee et al.
8,549,157 B2 10/2013 Schnellbaecher
8,555,248 B2 10/2013 Brunswig et al.
8,560,636 B2 10/2013 Kieselbach
8,560,713 B2 10/2013 Moreira Sa de Souza et al.
8,566,193 B2 10/2013 Singh et al.
8,571,908 B2 10/2013 Li et al.
8,572,107 B2 10/2013 Fan et al.
8,577,904 B2 11/2013 Marston
8,578,059 B2 11/2013 Odayappan et al.
8,578,328 B2 11/2013 Kamiyama et al.
8,578,330 B2 11/2013 Dreiling et al.
8,584,082 B2 11/2013 Baird et al.
8,588,765 B1 11/2013 Harrison
8,594,023 B2 11/2013 He et al.
8,635,254 B2 1/2014 Harvey et al.
8,689,181 B2 4/2014 Biron, III
8,752,074 B2 6/2014 Hansen
8,762,497 B2 6/2014 Hansen
8,769,095 B2 7/2014 Hart et al.
8,788,632 B2 7/2014 Taylor et al.
8,898,294 B2 11/2014 Hansen
2002/0138596 A1 9/2002 Darwin et al.
2003/0093710 A1 5/2003 Hashimoto et al.
2003/0117280 A1 6/2003 Prehn
2004/0027376 A1 2/2004 Calder et al.
2004/0133635 A1 7/2004 Spriestersbach et al.
2004/0158455 A1 8/2004 Spivack et al.
2004/0158629 A1 8/2004 Herbeck et al.
2004/0177124 A1 9/2004 Hansen
2005/0015369 A1 1/2005 Styles et al.
2005/0021506 A1 1/2005 Sauermann et al.
2005/0027675 A1 2/2005 Schmitt et al.
2005/0060186 A1 3/2005 Blowers et al.
2005/0102362 A1 5/2005 Price et al.
2005/0198137 A1 9/2005 Pavlik et al.
2005/0213563 A1 9/2005 Shaffer et al.
2005/0240427 A1 10/2005 Crichlow
2005/0289154 A1 12/2005 Weiss et al.
2006/0186986 A1 8/2006 Ma et al.
2006/0208871 A1 9/2006 Hansen
2007/0005736 A1 1/2007 Hansen et al.
2007/0016557 A1 1/2007 Moore et al.
2007/0027854 A1 2/2007 Rao et al.
2007/0027914 A1 2/2007 Agiwal
2007/0162486 A1 7/2007 Brueggemann et al.
2007/0174158 A1 7/2007 Bredehoeft et al.
2007/0260593 A1 11/2007 Delvat
2007/0266384 A1 11/2007 Labrou et al.
2007/0300172 A1 12/2007 Runge et al.
2008/0098085 A1 4/2008 Krane et al.
2008/0172632 A1 7/2008 Stambaugh
2008/0208890 A1 8/2008 Milam
2008/0222599 A1 9/2008 Nathan et al.
2008/0231414 A1 9/2008 Canosa
2008/0244594 A1 10/2008 Chen et al.
2008/0255782 A1 10/2008 Bilac et al.
2008/0319947 A1 12/2008 Latzina et al.
2009/0006391 A1 1/2009 Ram
2009/0150431 A1 6/2009 Schmidt et al.
2009/0193148 A1 7/2009 Jung et al.
2009/0259442 A1 10/2009 Gandikota et al.
2009/0265760 A1 10/2009 Zhu et al.
2009/0299990 A1 12/2009 Setlur et al.
2009/0300060 A1 12/2009 Beringer et al.
2009/0319518 A1 12/2009 Koudas et al.
2009/0327337 A1 12/2009 Lee et al.
2010/0017379 A1 1/2010 Naibo et al.
2010/0017419 A1 1/2010 Francis et al.
2010/0064277 A1 3/2010 Baird et al.
2010/0077001 A1 3/2010 Vogel et al.
2010/0094843 A1 4/2010 Cras
2010/0125584 A1 5/2010 Navas
2010/0125826 A1 5/2010 Rice et al.
2010/0250440 A1 9/2010 Wang et al.
2010/0257242 A1 10/2010 Morris
2010/0286937 A1 11/2010 Hedley et al.
2010/0287075 A1 11/2010 Herzog et al.
2010/0293360 A1 11/2010 Schoop et al.
2011/0078599 A1 3/2011 Guertler et al.
2011/0078600 A1 3/2011 Guertler et al.
2011/0099190 A1 4/2011 Kreibe

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0137883 A1 6/2011 Lagad et al.
2011/0138354 A1 6/2011 Hertenstein et al.
2011/0145712 A1 6/2011 Pontier et al.
2011/0145933 A1 6/2011 Gambhir et al.
2011/0153505 A1 6/2011 Brunswig et al.
2011/0154226 A1 6/2011 Guertler et al.
2011/0161409 A1 6/2011 Nair et al.
2011/0173203 A1 7/2011 Jung et al.
2011/0173220 A1 7/2011 Jung et al.
2011/0173264 A1 7/2011 Kelly
2011/0208788 A1 8/2011 Heller et al.
2011/0209069 A1 8/2011 Mohler
2011/0219327 A1 9/2011 Middleton, Jr. et al.
2011/0231592 A1 9/2011 Bleier et al.
2011/0276360 A1 11/2011 Barth et al.
2011/0307295 A1 12/2011 Steiert et al.
2011/0307363 A1 12/2011 N et al.
2011/0307405 A1 12/2011 Hammer et al.
2011/0320525 A1 12/2011 Agarwal et al.
2012/0005577 A1 1/2012 Chakra et al.
2012/0059856 A1 3/2012 Kreibe et al.
2012/0072435 A1 3/2012 Han
2012/0072885 A1 3/2012 Taragin et al.
2012/0078959 A1 3/2012 Cho et al.
2012/0096429 A1 4/2012 Desai et al.
2012/0131473 A1 5/2012 Biron, III
2012/0136649 A1 5/2012 Freising et al.
2012/0143970 A1 6/2012 Hansen
2012/0144370 A1 6/2012 Kemmler et al.
2012/0150859 A1 6/2012 Hu
2012/0158914 A1 6/2012 Hansen
2012/0166319 A1 6/2012 Deledda et al.
2012/0167006 A1 6/2012 Tillert et al.
2012/0173671 A1 7/2012 Callaghan et al.
2012/0197488 A1 8/2012 Lee et al.
2012/0197852 A1 8/2012 Dutta et al.
2012/0197856 A1 8/2012 Banka et al.
2012/0197898 A1 8/2012 Pandey et al.
2012/0197911 A1 8/2012 Banka et al.
2012/0239381 A1 9/2012 Heidasch
2012/0239606 A1 9/2012 Heidasch
2012/0254825 A1 10/2012 Sharma et al.
2012/0259932 A1 10/2012 Kang et al.
2012/0284259 A1 11/2012 Jehuda
2012/0311501 A1 12/2012 Nonez et al.
2012/0311526 A1 12/2012 DeAnna et al.
2012/0311547 A1 12/2012 DeAnna et al.
2012/0324066 A1 12/2012 Alam et al.
2013/0006400 A1 1/2013 Caceres et al.
2013/0036137 A1 2/2013 Ollis et al.
2013/0054563 A1 2/2013 Heidasch
2013/0060791 A1 3/2013 Szalwinski et al.
2013/0067031 A1 3/2013 Shedrinsky
2013/0067302 A1 3/2013 Chen et al.
2013/0073969 A1 3/2013 Blank et al.
2013/0080898 A1 3/2013 Lavian et al.
2013/0110496 A1 5/2013 Heidasch
2013/0110861 A1 5/2013 Roy et al.
2013/0124505 A1 5/2013 Bullotta et al.
2013/0124616 A1 5/2013 Bullotta et al.
2013/0125053 A1 5/2013 Brunswig et al.
2013/0132385 A1 5/2013 Bullotta et al.
2013/0166563 A1 6/2013 Mueller et al.
2013/0166569 A1 6/2013 Navas
2013/0173062 A1 7/2013 Koenig-Richardson
2013/0179565 A1 7/2013 Hart et al.
2013/0185593 A1 7/2013 Taylor et al.
2013/0185786 A1 7/2013 Dyer et al.
2013/0191767 A1 7/2013 Peters et al.
2013/0207980 A1 8/2013 Ankisettipalli et al.
2013/0211555 A1 8/2013 Lawson et al.
2013/0246897 A1 9/2013 O'Donnell
2013/0262641 A1 10/2013 Zur et al.
2013/0275344 A1 10/2013 Heidasch
2013/0275550 A1 10/2013 Lee et al.
2013/0304581 A1 11/2013 Soroca et al.
2014/0019432 A1 1/2014 Lunenfeld
2014/0282370 A1 9/2014 Schaefer et al.

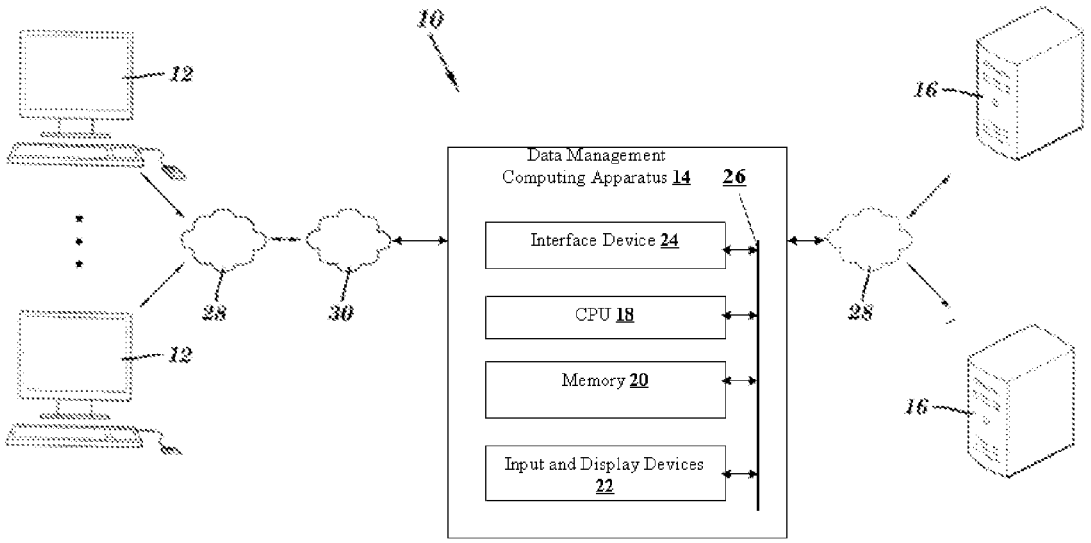

10
12
12
28
30
28
16
16
Data Management
Computing Apparatus 14
26
Interface Device 24
CPU 18
Memory 20
Input and Display Devices
22

FIG. 1

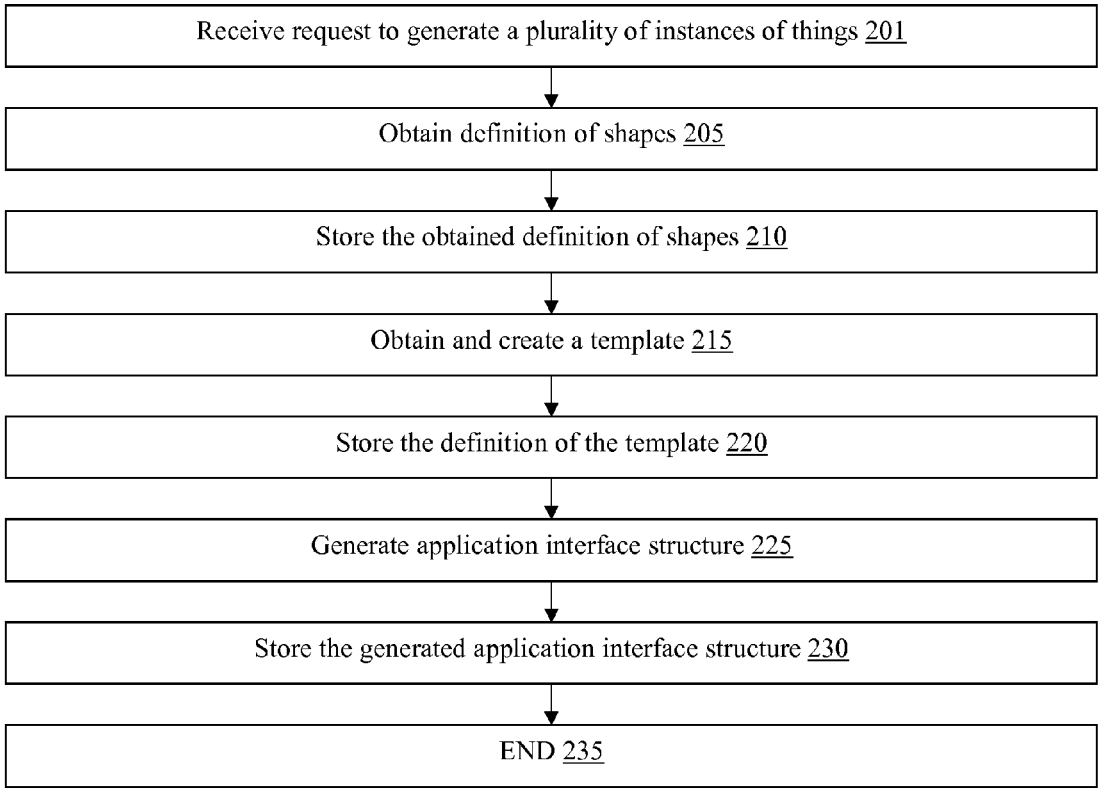

Receive request to generate a plurality of instances of things 201
Obtain definition of shapes 205
Store the obtained definition of shapes 210
Obtain and create a template 215
Store the definition of the template 220
Generate application interface structure 225
Store the generated application interface structure 230
END 235

FIG. 2

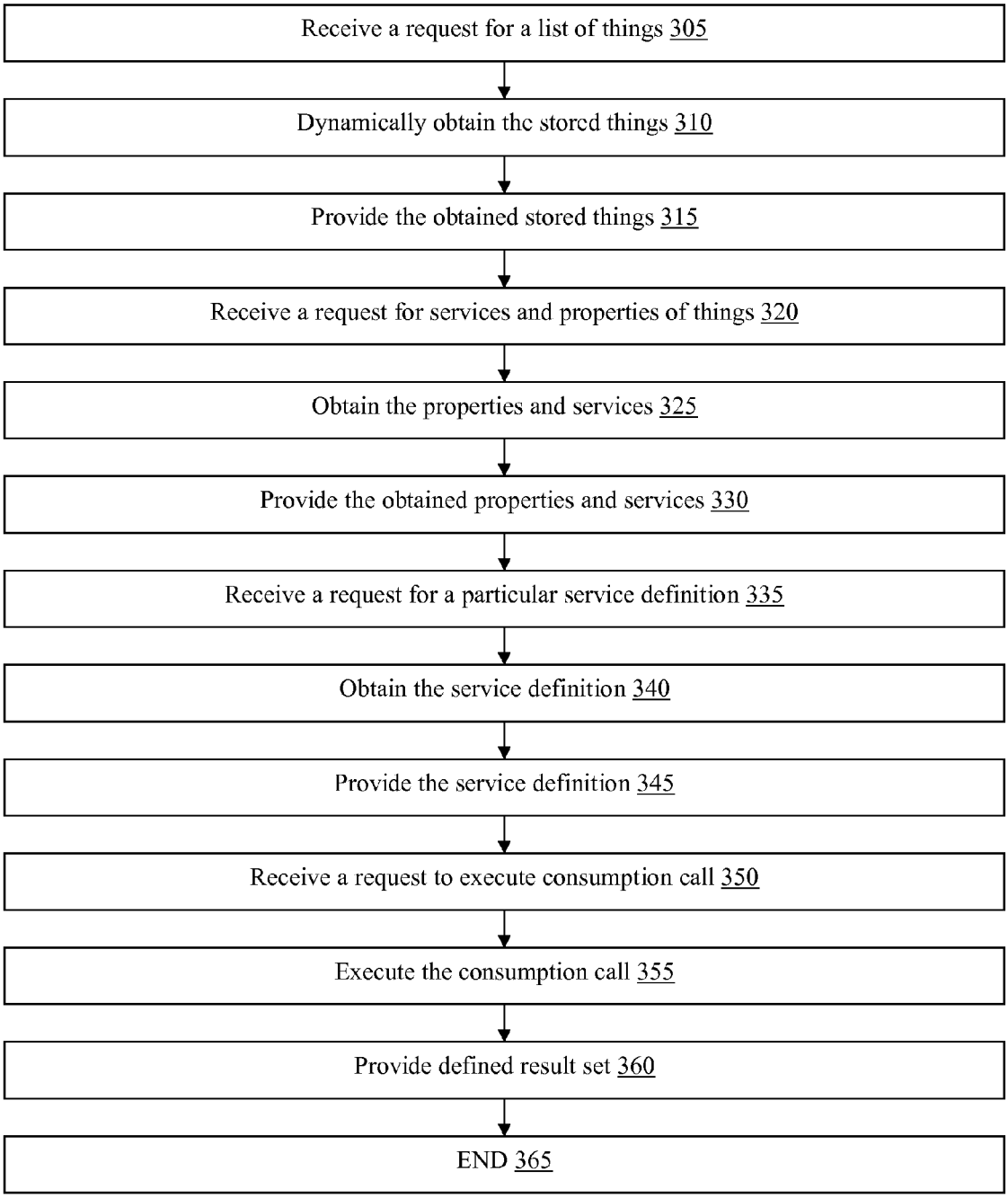

Receive a request for a list of things 305
Dynamically obtain the stored things 310
Provide the obtained stored things 315
Receive a request for services and properties of things 320
Obtain the properties and services 325
Provide the obtained properties and services 330
Receive a request for a particular service definition 335
Obtain the service definition 340
Provide the service definition 345
Receive a request to execute consumption call 350
Execute the consumption call 355
Provide defined result set 360
END 365

FIG. 3

METHODS FOR DYNAMICALLY GENERATING AN APPLICATION INTERFACE FOR A MODELED ENTITY AND DEVICES THEREOF

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/560,371 filed Nov. 16, 2011, which is hereby incorporated by reference in its entirety.

FIELD

This technology relates to methods for generating a dynamic representational state of a thing and devices thereof.

BACKGROUND

Most software applications allow a user or developer to manipulate data within the application. Accordingly, existing technologies have developed design tools to assist application software developer in designing an application interface.

Unfortunately, existing interface development technologies and designs have not kept pace with the increasing demand for interfaces. For example, the existing interface development technologies are not equipped to address current conditions, such as rapidly changing data sets which are accessible in different manners, at different locations and in different formats. Attempts with existing interface development technologies to provide self service capability have been limited to previously designed semantic models. Further, many of these design tools require specialized training to be able to use them to develop an application interface.

To meet these increased demands for interfaces, developers of these interfaces need all the required information for the application interface to be easily and readily available. Additionally, developers of these interfaces need to be able quickly obtain and understand all of the relationships that exist within the application.

SUMMARY

A method for generating a dynamic representational state of a thing includes generating by a data management computing apparatus a plurality of instances of things. Each of the instances of things comprises a dynamically generated interface structure and one or more services associated with and one or more properties of the corresponding one of the things. The one or more services associated with and the one or more properties of one of the plurality of instances of things for a selected one of the plurality of instances of things are retrieved and provided by the data management computing apparatus. A service definition for a selected one of the one or more services is retrieved and provided by the data management computing apparatus based on the retrieved and provided one or more services associated with and one or more properties for the selected one of the plurality of instances of things. A requested consumption call for the selected one of the services is executed by the data management computing apparatus based on the retrieved service definition. A defined result set for the executed consumption call is provided by the data management computing apparatus in the dynamically generated interface structure associated with the requested one of the plurality of instances of things.

A non-transitory computer readable medium having stored thereon instructions for generating a dynamic representational state of a thing comprising machine executable code which when executed by at least one processor, causes the processor to perform steps including generating a plurality of instances of things. Each of the instances of things comprises a dynamically generated interface structure and one or more services associated with and one or more properties of the corresponding one of the things. The one or more services associated with and the one or more properties of one of the plurality of instances of things for a selected one of the plurality of instances of things are retrieved and provided. A service definition for a selected one of the one or more services is retrieved and provided based on the retrieved and provided one or more services associated with and one or more properties for the selected one of the plurality of instances of things. A requested consumption call for the selected one of the services is executed based on the retrieved service definition. A defined result set for the executed consumption call is provided in the dynamically generated interface structure associated with the requested one of the plurality of instances of things.

A data management computing apparatus comprising one or more processors, a memory coupled to the one or more processors which are configured to execute programmed instructions stored in the memory includes generating a plurality of instances of things. Each of the instances of things comprises a dynamically generated interface structure and one or more services associated with and one or more properties of the corresponding one of the things. The one or more services associated with and the one or more properties of one of the plurality of instances of things for a selected one of the plurality of instances of things are retrieved and provided. A service definition for a selected one of the one or more services is retrieved and provided based on the retrieved and provided one or more services associated with and one or more properties for the selected one of the plurality of instances of things. A requested consumption call for the selected one of the services is executed based on the retrieved service definition. A defined result set for the executed consumption call is provided in the dynamically generated interface structure associated with the requested one of the plurality of instances of things.

Accordingly, this technology provides a number of advantages including providing methods, non-transitory computer readable medium and apparatuses that more easily and effectively generate and provide through an interface a dynamic representational state of a thing. With this technology all of the interrelationships which exist in the dynamic representational state information are easily and readily available. Additionally, with this technology no specialized training is required.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of an exemplary network environment which comprises a data management computing apparatus for generating and providing through an interface a dynamic representational state of a thing;

FIG. **2** is a flowchart of an exemplary method for dynamically generating one or more of a plurality of instances of things; and

FIG. **3** is a flowchart of an exemplary method for generating and providing through an interface a dynamic representational state of a thing.

DETAILED DESCRIPTION

An exemplary environment **10** with a data management computing apparatus **14** that generates and provides through an interface a dynamic representational state of a thing is illustrated in FIG. **1**. In this particular example, the environ-

ment **10** includes a data management computing apparatus **14**, a plurality of consumer computing device **12**, and a plurality of data servers **16** which are coupled together by the Local Area Network (LAN) **28** and Wide Area Network (WAN) **30**, although the environment **10** can include other types and numbers of devices, components, elements and communication networks in other topologies and deployments. While not shown, the exemplary environment **10** may include additional components, such as routers, switches and other devices which are well known to those of ordinary skill in the art and thus will not be described here. This technology provides a number of advantages including providing methods, non-transitory computer readable medium and apparatuses that more easily and effectively generate and provide through an interface a dynamic representational state of a thing.

Referring more specifically to FIG. **1**, the data management computing apparatus **14** provides a number of functions including generating a dynamic representational state of a thing, although other numbers and types of systems can be used and other numbers and types of functions can be performed. The data management computing apparatus **14** includes at least one processor **18**, memory **20**, input and display devices **22**, and interface device **24** which are coupled together by bus **26**, although data management computing apparatus **14** may comprise other types and numbers of elements in other configurations.

Processor(s) **18** may execute one or more computer-executable instructions stored in the memory **20** for the methods illustrated and described with reference to the examples herein, although the processor(s) can execute other types and numbers of instructions and perform other types and numbers of operations. The processor(s) **18** may comprise one or more central processing units ("CPUs") or general purpose processors with one or more processing cores, such as AMD® processor(s), although other types of processor(s) could be used (e.g., Intel®).

Memory **20** may comprise one or more tangible storage media, such as RAM, ROM, flash memory, CD-ROM, floppy disk, hard disk drive(s), solid state memory, DVD, or any other memory storage types or devices, including combinations thereof, which are known to those of ordinary skill in the art. Memory **20** may store one or more non-transitory computer-readable instructions of this technology as illustrated and described with reference to the examples herein that may be executed by the one or more processor(s) **18**. The flow chart shown in FIGS. **2** and **3** is representative of example steps or actions of this technology that may be embodied or expressed as one or more non-transitory computer or machine readable instructions stored in memory **20** that may be executed by the processor(s) **18**.

Input and display devices **22** enable a user, such as an administrator, to interact with the data management computing apparatus **14**, such as to input and/or view data and/or to configure, program and/or operate it by way of example only. Input devices may include a touch screen, keyboard and/or a computer mouse and display devices may include a computer monitor, although other types and numbers of input devices and display devices could be used. Additionally, the input and display devices **22** can be used by the user, such as an administrator to develop applications using an application interface.

The interface device **24** in the data management computing apparatus **14** is used to operatively couple and communicate between the data management computing apparatus **14**, the client computing device **12**, and the plurality of data servers which are all coupled together by LAN **28** and WAN **30**. By way of example only, the interface device **24** can use TCP/IP over Ethernet and industry-standard protocols, including NFS, CIFS, SOAP, XML, LDAP, and SNMP although other types and numbers of communication protocols can be used.

Each of the consumer computing devices **12** includes a central processing unit (CPU) or processor, a memory, an interface device, and an I/O system, which are coupled together by a bus or other link, although other numbers and types of network devices could be used. Each of the consumer computing devices **12** communicates with the data management computing apparatus **14** through LAN **28**, although the consumer computing devices **12** can interact with the data management computing apparatus **14** by any other means. The consumer computing device **12** utilizes the dynamically generated interface provided by the data management computing apparatus **14** to access modeled data and other information from one or more data servers **16**.

Each of the plurality of data servers **16** includes a central processing unit (CPU) or processor, a memory, an interface device, and an I/O system, which are coupled together by a bus or other link, although other numbers and types of network devices could be used. Each of the plurality of data servers **16** enters, updates and/or store content, such as files and directories, although other numbers and types of functions can be implemented and other types and amounts of data could be entered, updated, or stored used. Each of the plurality of data servers **16** may include by way of example only, enterprise resource planning (ERP) systems, portals and related technologies, traditional business intelligence systems and manufacturing intelligence systems.

Although an exemplary environment **10** with the consumer computing devices **12**, the data management computing apparatus **14** and the plurality of data servers **16** are described and illustrated herein, other types and numbers of systems, devices in other topologies can be used. It is to be understood that the systems of the examples described herein are for exemplary purposes, as many variations of the specific hardware and software used to implement the examples are possible, as will be appreciated by those skilled in the relevant art(s).

In addition, two or more computing systems or devices can be substituted for any one of the systems or devices in any example. Accordingly, principles and advantages of distributed processing, such as redundancy and replication also can be implemented, as desired, to increase the robustness and performance of the devices and systems of the examples. The examples may also be implemented on computer system(s) that extend across any suitable network using any suitable interface mechanisms and traffic technologies, including by way of example only teletraffic in any suitable form (e.g., voice and modem), wireless traffic media, wireless traffic networks, cellular traffic networks, 3G traffic networks, Public Switched Telephone Network (PSTNs), Packet Data Networks (PDNs), the Internet, intranets, and combinations thereof.

Furthermore, each of the systems of the examples may be conveniently implemented using one or more general purpose computer systems, microprocessors, digital signal processors, and micro-controllers, programmed according to the teachings of the examples, as described and illustrated herein, and as will be appreciated by those of ordinary skill in the art.

The examples may also be embodied as a non-transitory computer readable medium having instructions stored thereon for one or more aspects of the technology as described and illustrated by way of the examples herein, which when executed by a processor (or configurable hard-

ware), cause the processor to carry out the steps necessary to implement the methods of the examples, as described and illustrated herein.

An exemplary method for dynamically generating one or more of a plurality of instances of things will now be described with reference to FIGS. **1-2**. In step **201**, the data management computing apparatus **14** receives a request to generate one or more of a plurality of instances of things from a consumer computing device **12**, although this process can be initiated in other manners, such as by the data management computing apparatus **14**.

Next, in step **205** the data management computing apparatus **14** obtains a defined shape for a modeled entity which is referred to in this patent application as a thing, from the requesting consumer computing device **12**, although the data management computing apparatus **14** may obtain the defined shape from other sources, such as from one of the plurality of data servers **16** by way of example only. In these examples, a thing refers to people, apparatuses, systems, electronic or mechanical devices, components or other elements which are projections of real world equivalents containing sets of data, services, events, historical activities, collaboration, relationships and user interfaces that define it and its place in the real world. Additionally, in these examples shape refers to attributes of the thing which is being generated, such as events, service definitions, or services and subscriptions offered by the thing.

In step **210**, the data management computing apparatus **14** stores the obtained defined shapes for the thing in memory **20** in one or more graph databases and indexes, although the data management computing apparatus **14** can store the obtained defined shapes for the thing at a different memory location, such as at one of the plurality of data servers **16** by way of example only. Additionally, in this technology, the data management computing apparatus **14** assigns tags to the obtained defined shape of the thing while storing the obtained defined shape and further stores the assigned tag and the exact memory location in the indexes present within the memory **20**. By assigning tags and storing the obtained definition in the memory **20** and by using the indexes, the technology illustrated in this application provides rapid retrieval of the stored information.

In step **215**, the data management computing apparatus **14** obtains a defined template from the requesting consumer computing device **12**, although the data management computing apparatus **14** can obtain the defined template from other sources, such as from one of the plurality of data servers **16**.

In step **220**, the data management computing apparatus **14** stores the defined template using techniques as illustrated in step **210**.

In step **225**, the data management computing apparatus **14** generates an application interface structure for the instance of the thing based on the defined shape, the defined template and the properties and services of the thing. The generated application interface structure for the thing also includes service definitions which can be obtained from one or more of the plurality of data servers **16**, although the generated application interface can include other types and amounts of information relating to the thing.

In step **230**, the data management computing apparatus **14** stores the instance of the thing with the generated application interface structure, the service definitions, list of all properties and services offered by the thing, the defined shape and the defined template. This exemplary method can be repeated to generate additional instance of things in the exemplary manner described herein and then ends in step **235**. By following the above exemplary steps to generate an application interface structure, this technology assists developers to build and deploy operational interface structures which are more dynamic and easier to use and navigate in less time than was possible with prior approaches.

An exemplary method for generating and providing through an interface a dynamic representational state of a thing will now be described with reference to FIGS. **1** and **3**. In step **305** the data management computing apparatus **14** receives a request from a consumer computing device **12** for a list of things, although the data management computing apparatus **14** can receive any other types and numbers of requests from the consumer computing device **12**. Next, in step **310** the data management computing apparatus **14** obtains the list of things from memory **20**, although data management computing apparatus **14** can obtain the list of things from other sources and in other manners. Next, in step **315** the data management computing apparatus **14** provides the obtained list of things to the requesting consumer computing device **12**.

In step **320**, the data management computing apparatus **14** receives another request from the consumer computing device **12** for the services and properties of the previously requested thing based on a selection of the one thing instances from the previously provided list. Next, in step **325**, the data management computing apparatus **14** obtains the properties and services associated with the requested thing from the stored instance of the thing in memory **20**, although the properties and services associated with the requested thing could be obtained from other sources in other manners. Next, in step **330**, the data management computing apparatus **14** provides the obtained properties and services associated with the requested thing to the requesting consumer computing device **12**.

In step **335**, the data management computing apparatus **14** receives another request from the consumer computing device **12** for a particular service definition for one of the previously provided services in the instance of the thing associated with the requested thing. Next, in step **340**, the data management computing apparatus **14** obtains the service definition for the requested service from memory **20**, although the service definition could be obtained from other sources in other manners. Next, in step **345** the data management computing apparatus **14** provides the service definition to the requesting consumer computing device **12** using techniques illustrated in step **310**.

In step **350**, the data management computing apparatus **14** receives a request to execute a consumption call for the thing relating to the previously provided service definition from the consumer computing device **12**. Next, in step **355** the data management computing apparatus **14** executes the requested consumption call for the service definition associated with a service of the requested thing, although other types and numbers of functions could be executed.

In step **360**, upon executing the consumption call, the data management computing apparatus **14** provides the defined result set for the executed consumption call in the dynamically generated interface structure associated with the requested one of the plurality of instances of things to the requesting one of the consumer computing device **12**. Next, the steps above can be repeated again in response to another request, otherwise this exemplary method ends in step **365**.

Accordingly, as illustrated and described with the examples herein this technology provides methods, non-transitory computer readable medium and apparatuses that more easily and effectively generate and provide through an interface a dynamic representational state of a thing. With this

technology all of the interrelationships which exist in the dynamic representational state information are easily and readily available. Additionally, with this technology no specialized training is required.

Having thus described the basic concept of this technology, it will be rather apparent to those skilled in the art that the foregoing detailed disclosure is intended to be presented by way of example only, and is not limiting. Various alterations, improvements, and modifications will occur and are intended to those skilled in the art, though not expressly stated herein. These alterations, improvements, and modifications are intended to be suggested hereby, and are within the spirit and scope of this technology. Additionally, the recited order of processing elements or sequences, or the use of numbers, letters, or other designations therefore, is not intended to limit the claimed processes to any order except as may be specified in the claims. Accordingly, this technology is limited only by the following claims and equivalents thereto.

What is claimed is:

1. A method for generating a dynamic representational state of a thing, the method comprising:

generating by a data management computing apparatus a plurality of instances of things, each of the instances of things comprising a dynamically generated interface structure and one or more services associated with, and one or more properties of, a corresponding thing;

retrieving and providing by the data management computing apparatus the one or more services associated with, and the one or more properties of, a selected one of the plurality of instances of things;

retrieving and providing by the data management computing apparatus a service definition for a selected one of the one or more services based on the retrieved and provided one or more services associated with, and one or more properties for, the selected one of the plurality of instances of things;

executing by the data management computing apparatus a requested consumption call for the selected one of the one or more services based on the retrieved service definition; and

providing by the data management computing apparatus a defined result set for the executed consumption call in the dynamically generated interface structure associated with the requested one of the plurality of instances of things,

wherein the generating the plurality of instances of things comprises:

receiving by the data management computing apparatus the one or more services and the one or more properties associated with each of the generated plurality of instances of things; and

persisting by the data management computing apparatus each of the generated plurality of instances of things with the corresponding received one or more services and the one or more properties;

wherein the generating the plurality of instances of things comprises:

receiving by the data management computing apparatus a defined shape for each of the generated plurality of instances of things;

receiving by the data management computing apparatus a defined template for each of the generated plurality of instances of things;

generating by the data management computing apparatus the dynamically generated interface structure based on the received defined shape, the received defined template and the received one or more properties for each of the generated plurality of instances of things; and

persisting by the data management computing apparatus the dynamically generated interface structure for each of the generated plurality of instances of things.

2. The method as set forth in claim **1** further comprising:

providing by the data management computing apparatus a list of the generated plurality of instances of things; and

receiving by the data management computing apparatus a selection of the one of the generated plurality of instances of things.

3. A non-transitory computer readable medium having stored thereon instructions, for generating a dynamic representational state of a thing, comprising machine executable code, which when executed by at least one processor, causes the processor to perform steps comprising:

generating a plurality of instances of things, each of the instances of things comprising a dynamically generated interface structure and one or more services associated with and one or more properties of, a corresponding thing;

retrieving and providing the one or more services associated with, and the one or more properties, for a selected one of the plurality of instances of things;

retrieving and providing a service definition for a selected one of the one or more services based on the retrieved and provided one or more services associated with and one or more properties for, the selected one of the plurality of instances of things;

executing a requested consumption call for the selected one of the one or more services based on the retrieved service definition; and

providing a defined result set for the executed consumption call in the dynamically generated interface structure associated with the requested one of the plurality of instances of things,

wherein the instructions comprises machine executable code, which when executed by the at least one processor, causes the processor to perform steps comprising:

receiving the one or more services and the one or more properties associated with each of the generated plurality of instances of things; and

persisting each of the generated plurality of instances of things with the corresponding received one or more services and the one or more properties;

wherein the instructions comprises machine executable code, which when executed by the at least one processor, causes the processor to perform steps comprising:

receiving a defined shape for each of the generated plurality of instances of things;

receiving a defined template for each of the generated plurality of instances of things;

generating the dynamically generated interface structure based on the received defined shape, the received defined template and the received one or more properties for each of the generated plurality of instances of things; and

persisting the dynamically generated interface structure for each of the generated plurality of instances of things.

4. The medium as set forth in claim **3**, wherein the instructions comprise machine executable code, which when executed by the at least one processor, causes the processor to perform steps comprising:

providing a list of the generated plurality of instances of things; and

receiving a selection of the one of the generated plurality of instances of things.

5. A data management computing apparatus comprising:

one or more processors;

a memory coupled to the one or more processors which are configured to execute programmed instructions stored in the memory for performing steps comprising:

generating a plurality of instances of things, each of the instances of things comprising a dynamically generated interface structure and one or more services associated with, and one or more properties of, a corresponding thing;

retrieving and providing the one or more services associated with, and the one or more properties of, for a selected one of the plurality of instances of things;

retrieving and providing a service definition for a selected one of the one or more services based on the retrieved and provided one or more services associated with and one or more properties for, the selected one of the plurality of instances of things;

executing a requested consumption call for the selected one of the one or more services based on the retrieved service definition; and

providing a defined result set for the executed consumption call in the dynamically generated interface structure associated with the requested one of the plurality of instances of things,

wherein the one or more processors are configured to execute programmed instructions stored in the memory for the generating the plurality of instances of things comprising:

receiving the one or more services and the one or more properties associated with each of the generated plurality of instances of things; and

persisting each of the generated plurality of instances of things with the corresponding received one or more services and the one or more properties;

wherein the one or more processors are configured to execute programmed instructions stored in the memory for the generating the plurality of instances of things comprising:

receiving a defined shape for each of the generated plurality of instances of things;

receiving a defined template for each of the generated plurality of instances of things;

generating the dynamically generated interface structure based on the received defined shape, the received defined template and the received one or more properties for each of the generated plurality of instances of things; and

persisting the dynamically generated interface structure for each of the generated plurality of instances of things.

6. The apparatus as set forth in claim **5** wherein the one or more processors are configured to execute programmed instructions stored in the memory to perform steps comprising:

providing a list of the generated plurality of instances of things; and

receiving a selection of the one of the generated plurality of instances of things.

* * * * *